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HABITAT DESTRUCTION IS AFFECTING THE FACIAL FEATURES OF ORANGUTANS

Alexandra E. Kralick[1*] *and Kate McGrath*[2,3]

[1] *Department of Anthropology, University of Pennsylvania, Philadelphia, PA, United States*
[2] *Department of Anthropology, State University of New York Oneonta, Oneonta, NY, United States*
[3] *Department of Anthropology, The George Washington University, Washington, DC, United States*

YOUNG REVIEWER:

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AGE: 10

Orangutans are endangered primates that live in Asian forests. Each year, these forests are becoming more stressful to live in because of habitat destruction and deforestation. The stress of habitat change may affect some orangutans more than others. As male orangutans age, some of them grow big cheek pads on their faces, called flanges (flanged males), while others keep their kid faces (unflanged males). Scientists still do not understand why orangutans grow up to become one type or the other, but stress might help explain it. To test this, we examined orangutan teeth for signs of stress that formed when they were kids. We found that unflanged males have less severe stress lines, meaning lower levels of childhood stress, compared to flanged males. Nowadays, most orangutans have high levels of stress due to habitat destruction and climate change. As a result, adult unflanged males may be disappearing from the wild altogether.

ORANGUTAN HABITATS ARE STRESSFUL

Orangutans are critically endangered and expected to go extinct in the next 50 years. As much as 97% of the orangutan population has been wiped out in the last century. The lives of orangutans are particularly hard because they eat mostly fruit, which naturally goes in and out of season and can be hard to find at times. Periods with less fruit are becoming more common due to environmental changes like habitat destruction, **climate change**, and massive wildfires. When fruit is not available, orangutans resort to eating bark. As a result, they go into starvation mode and lose muscle mass [1]. Starving, losing their homes to logging, and running from wildfires are all incredibly stressful.

In this study, we assessed how severe **stress** is recorded in orangutans' bodies and what it can tell us about how they are responding to habitat destruction. Specifically, we tested whether some types of orangutans respond to stress differently than others, based on analyses of their skin and teeth.

CLIMATE CHANGE

A global pattern of change in the environment, caused by humans, that puts Earth's ecosystems under threat.

STRESS

An organism's physical response to environmental or social pressure that forces that organism to adapt.

PUBERTY

A time between childhood and young adulthood when adolescents go through sex-specific physical changes to reach sexual maturity.

FLANGE

Cheek pads on the faces of some adult male orangutans.

TYPES OF ORANGUTANS

All young male orangutans start off looking the same, but when **puberty** hits, male orangutans differentiate into two distinct types. When humans go through puberty, boys grow beards and armpit hair. While orangutans also get hairier during puberty, they also develop something unique— some males develop face pads called **flanges** that female orangutans find attractive. You may have seen these orangutans at the zoo—they almost look like they have half frisbees glued to their cheeks (Figure 1B). These males are called flanged males.

Figure 1

(A) An unflanged male. **(B)** A flanged male (Photograph credit: Meredith Bastian, Sungai Lading Orangutan Field Project).

Adult male orangutans that do not develop face flanges still look like young orangutans as they age, and they are called adult unflanged males (Figure 1A). Unflanged males can delay the development of flanges for up to 20 years, or possibly may never flange. In the animal kingdom, it is unusual for a species to contain two kinds of adult males. Scientists still do not understand why adult unflanged male orangutans exist, and they are mysterious because they cannot be found in zoos. Some researchers have long suspected that stress may play a role.

HOW MIGHT HABITAT STRESS AFFECT ORANGUTANS?

Stress experienced during early life may help explain why some young male orangutans turn into flanged adults and others turn into unflanged adults. Adult unflanged males are lower ranking which means that they often lose out in fights and have fewer babies compared to higher ranking flanged males. In some animals, like baboons, lower-ranking males tend to experience more stress than higher-ranking males. However, once researchers started measuring hormone levels to assess orangutan stress, they found that, unlike baboons, the flanged males are *more* stressed out, even though they are higher ranking. So, we developed our hypothesis that adult unflanged males experienced less severe stress in their childhoods compared to flanged males.

Hormone studies support our hypothesis. An earlier study showed that adult unflanged male orangutans have the same or lower levels of stress hormones as flanged males. However, that study only looked at adults, not orangutans during their whole lives from childhood through puberty since that is much trickier to do. Adult unflanged males can only be found in the wild and tracking orangutans in the wild across their whole lives to study their stress hormones is much more challenging than in zoos. Orangutans live high up in the trees and often move away from the research study area when they grow up. Therefore, we decided to use a new method to analyze childhood stress: studying the effects of stress on the teeth of adult orangutan skeletons from museum collections.

TEETH GROW LIKE RINGS ON A TREE

Both teeth and trees hold incredibly detailed records of their growth. Trees grow bigger by adding new layers on the outer perimeter of their trunks every year. Because trees grow more with higher rainfall, rings from rainy years are particularly thick, and rings from years with droughts are particularly thin.

Teeth reflect a similar pattern—each week one new layer is created (Figure 2). You might not have noticed these layers yourself because

they are about the thickness of a single strand of hair! Orangutan teeth grow in two sets, just like ours. The first set of teeth grow when a baby is still inside its mother's womb. Around the time when the baby teeth start appearing in the mouth, a second set of teeth are still growing inside the jaw. These adult teeth keep growing throughout childhood and, when they were done, they push the baby teeth out and grow into the open spots.

STRESS EVENTS LEAVE MARKS ON TEETH

STRESS LINES

Grooves on the surface of teeth caused by periods of stress during childhood.

If kids experience stress while their teeth are growing inside their jaws, that stress leaves a record behind. When a child has a fever or an injury, for example, their body focuses on healing itself and takes a break from growing the teeth at that time. This leaves grooves, called **stress lines**, on the teeth that were in the process of forming (Figure 2). Stress lines, kind of like a year of drought in tree rings, show that the tooth did not grow as much as usual during those weeks of sickness or injury.

Orangutan teeth are full of both severe and more typical-looking stress lines (Figure 2). People and animals normally have some stress lines in their teeth, including from the time when they were born, because that is a really stressful event for both moms and babies. But, unless a person went through a period of starvation or a severe illness with a sustained fever, it is unlikely that they would have really deep stress lines on their teeth. Some of our previous research found that when apes or people experience severe stress events, like losing their families or experiencing very serious injuries, they get stress lines that are super deep compared to those caused by everyday stressors, like the common cold.

MEASURING STRESS IN ORANGUTAN TEETH

A century ago, scientists collected the skins, skulls, and skeletons of orangutans that passed away, and brought them to museums for researchers to study. We went to the collections of two museums—the Smithsonian's National Museum of Natural History in Washington, D.C., and the Academy of Natural Science in Philadelphia—to study these orangutan artifacts. We first identified which adult orangutans were which: flanged males had larger face measurements than did unflanged males (Figure 3).

We took dental molds from orangutan skulls to measure the stress lines in the teeth. This process is similar to the one that dentists use to mold your teeth before you get braces. The mold looks like an exact copy of the tooth, except it is black because it is made of a plastic-like material called epoxy (Figure 2). We then used a high-powered microscope to take 3D pictures of the stress lines and measure their depth, so that we could figure out the severity of stress

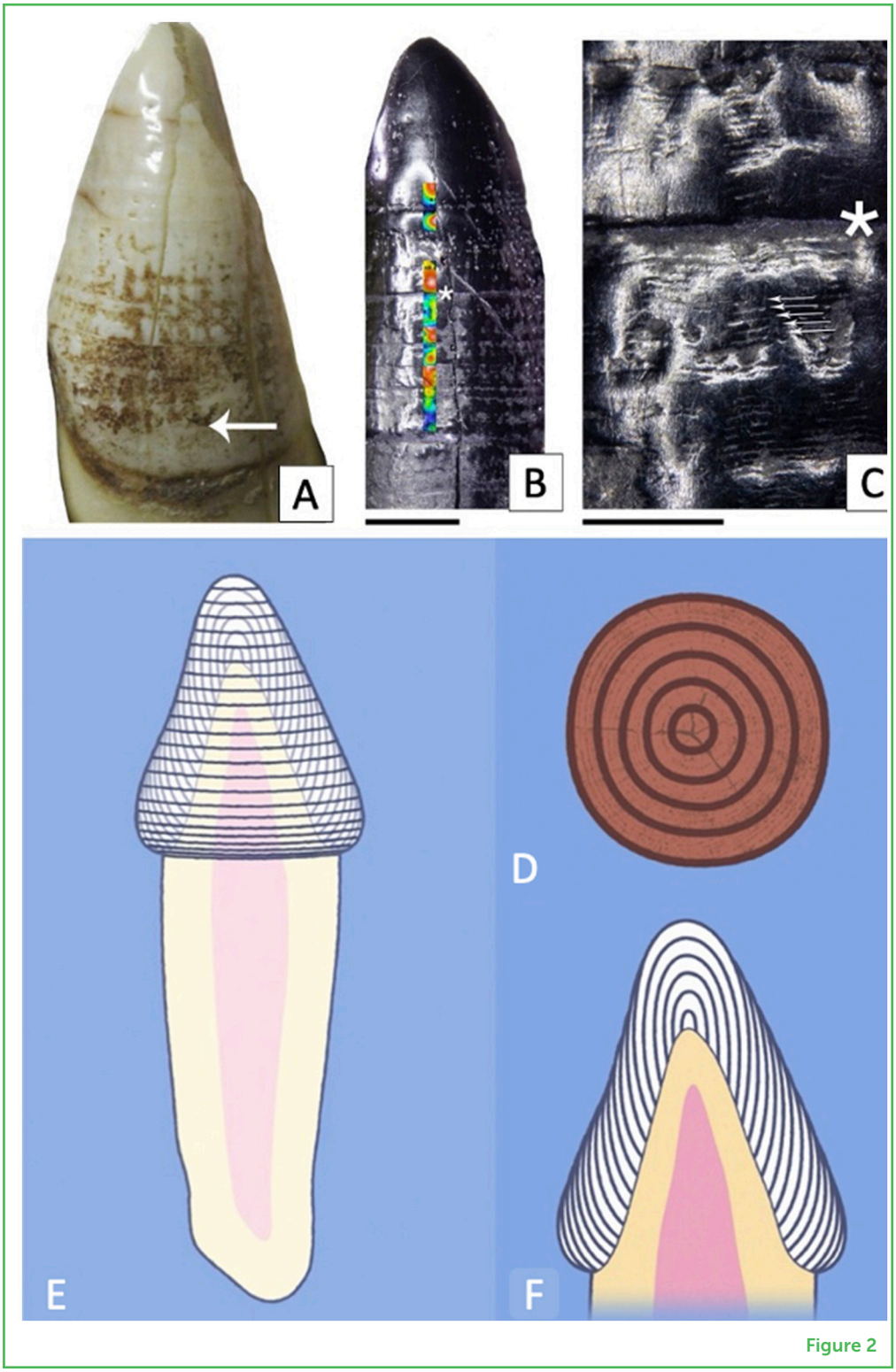

Figure 2

(A) Example of stress lines in a real orangutan canine. **(B, C)** A replica of a canine, showing a major stress line marked with an asterisk in both images. The colored part of panel **B** shows changes in height across the tooth. **(D)** Trees grow bigger by adding new layers on the outer perimeter of their trunks every year. **(E, F)** Like trees, teeth reflect a similar pattern—each week one new layer is created (Image credit: Sarah Crawley).

events experienced by each individual orangutan while they were growing up [2].

Figure 3

We measured the face sizes of male (flanged and unflanged) and female orangutans, from the eye to the ear (illustrated in a gray bracket). The box plots of these measurements show flanged males have larger faces than unflanged males and females, which tells us that the faces of adult unflanged males can be reliably distinguished from those of flanged males (Photograph credit: istock photograph).

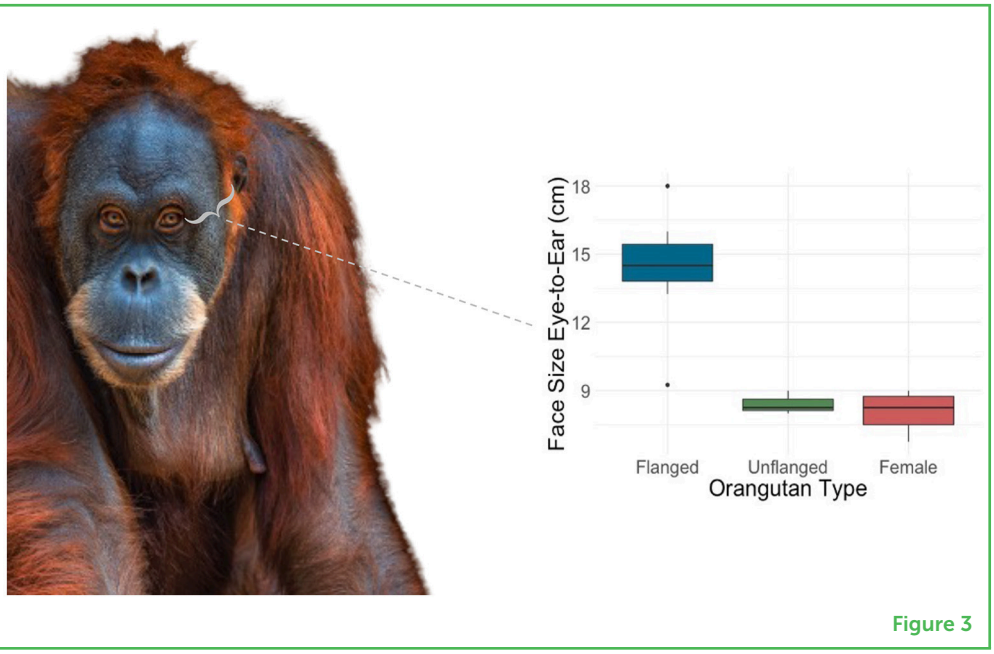

Figure 3

WHAT DID WE FIND?

We found that flanged males have much deeper stress lines than unflanged males. This supports our hypothesis that flanged males experienced more severe stress events during childhood, when their teeth were forming, compared to adult unflanged males. These results help us understand why two types of male orangutans may exist. Our research supports the idea that orangutan males who flange earlier do so because of greater childhood stress. In the future, it would be interesting to look at other factors that may help explain flanging, such as genetic differences between flanged and unflanged adult males.

WHY THIS MATTERS

Our results show that a stressful childhood usually leads to a male orangutan becoming a flanged adult. With orangutan childhoods becoming more stressful due to environmental changes like habitat destruction and climate change, it is likely that more male orangutans are becoming flanged at puberty. Our results also suggest that fewer orangutans will become adult unflanged males each year, which means that adult unflanged males may disappear from the wild altogether.

Among animals, adult unflanged male orangutans exhibit a rare and unique phenomenon. Since adult unflanged males are only found in the wild, and since the wild is becoming more stressful and possibly causing them to disappear, we have precious few years left to study them. If orangutans as a species have only 50 years left in the wild, adult unflanged males will likely become extinct long before that. Unfortunately, we still know so little about how and why adult

unflanged males exist. Studying them can also provide clues about how and why our fossil ancestors experienced stress when they were young. But we must save orangutans from extinction to understand any of that!

Saving the orangutans is possible—mountain gorillas were once saved from the brink of extinction. If we work hard enough through sustained and well-funded international conservation efforts, orangutans too could be saved from the brink of extinction.

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Kralick, A. E., and McGrath, K. 2021. More severe stress markers in the teeth of flanged versus unflanged orangutans (*Pongo* spp.). *Am. J. Phys. Anthropol.* 176:625–37. doi: 10.1002/ajpa.24387

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWER

PARITHI, AGE: 10
I really like insects and lizards. I also want to keep on learning about physics and ecosystems.

AUTHORS

ALEXANDRA E. KRALICK
Alexandra Kralick is a Ph.D. Candidate in anthropology at the University of Pennsylvania in Philadelphia. She studies the growth and development of sex differences in the great ape skeleton, in the field of biological anthropology. Her previous work is on gorilla dental development and wrist bone shape. Kralick is a former National Science Foundation Graduate Research Fellow and a Leakey Foundation grantee. She earned her B.S. in biological anthropology from The George Washington University. You can follow her on Twitter @BioAnthFunFacts.
*akralick@sas.upenn.edu

KATE MCGRATH
Kate McGrath is an Assistant Professor of Biological Anthropology at SUNY Oneonta in New York. She studies how early life stress affects the growth and development of bones and teeth. Her previous studies have focused on great apes, humans, and human ancestors. She is a former Marie Skłodowska-Curie Fellow and her work has been supported by the European Union, National Science Foundation, and Leakey Foundation. She earned her B.S. in anthropology from the College of Charleston, South Carolina, and Ph.D. in human paleobiology from The George Washington University. You can follow her on Twitter @kateapemcgrath.